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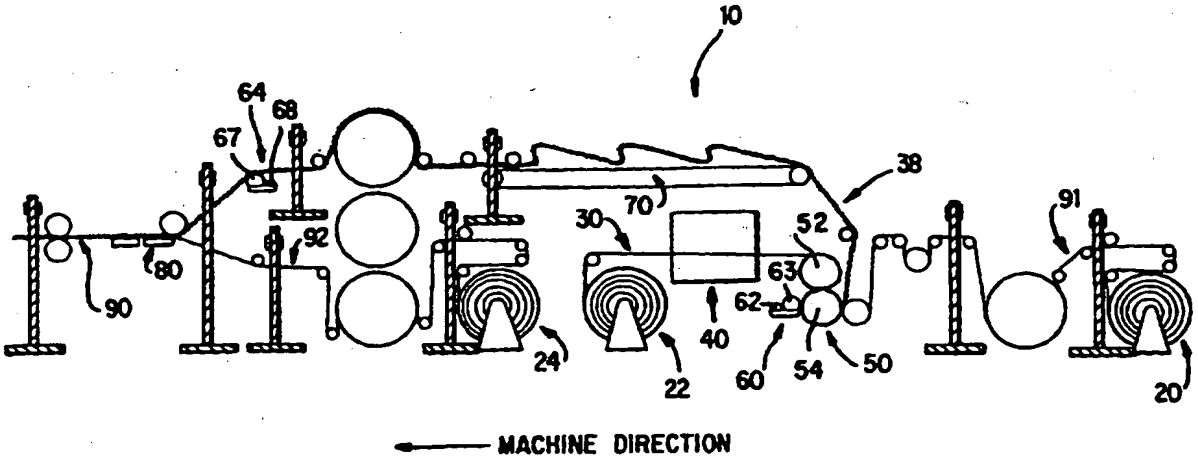

(57) Abstract

A process and apparatus for sizing corrugating material (30) for use between a pair of spaced apart linerboards (91, 92) to produce a corrugated containerboard (39) whereby corrugating material (30) is wetted on one or both sides with a coating of an environmentally friendly sizing curable sizing agent prior to application of an adhesive for gluing the linerboard (91, 92) onto the material. The sizing agent is subsequently cured and migrates through the corrugated medium structure.

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ON-LINE SIZING OF CORRUGATED PAPER

BACKGROUND OF THE INVENTION

This invention relates in general to the preparation and manufacture of a sized paper and, in particular, to the sizing of paper for use as a corrugating material in a corrugated containerboard.

Corrugating material for use in the fabrication of corrugated containerboard is typically manufactured by depositing pulp in a water carrier on a moving screen. The pulp is then pressed into a web and then dried. The corrugated material is then formed into a corrugated containerboard by sandwiching this material between a pair of spaced apart linerboards in a corrugating machine. Corrugated containerboard so formed is then cut into blanks and scored to form containers for shipment of goods therein.

Containers formed in this procedure can perform in an unsatisfactory manner when exposed to a high humidity or wetting conditions such as when shipping produce, dressed poultry or the like packed in the ice. The exposure of the corrugated containerboard to the water and water vapors rapidly deteriorates the corrugated containerboard and can collapse the board in a relatively short period of time. Eliminating this problem has become an object of industrial concern.

One method to overcome this problem adopted by the industry is to waterproof the containerboard with a sizing agent. In this method a boundary layer of a sizing agent is provided along the corrugating material region of the containerboard. Such a boundary layer can be quite effective in minimizing the foregoing problem.

Providing a containerboard with such a boundary layer is accomplished in the art in one of two ways. Use of a sizing agent at the wet end of a papermaking process --known as internal sizing-- in a papermaking machine is one way to size a containerboard described in the art. Ketene dimer dispersions for wet end application are described in U.S. Patent Nos. 2,865,743; 3,212,965; 4,207,142; 4,240,935; 4,859,244; 5,270,076. An alkenyl succinic anhydride composition is described in U.S. Patent No. 5,104,486 and 5,176,748. A self emulsifying sizing agent is described in U.S. Patent No, 5,190,616.

A second way to size a containerboard is to use a sizing agent in the drying section of a papermaking process -- normally referred to as surface sizing of external sizing-- in a papermaking machine. Various hydrophobic materials are used as external sizing agents, including rosin or rosin derivatives, U.S. Patent Nos. 4,597,831 and 5,206,044, paraffin waxes (U.S. Patent No. 3,431,162), synthetic resins (U.S. Patent No. 4,517,285) and chemically reactive sizing agents such as alkyl ketene dimer (U.S. Patent Nos. 4,407,994; 4,478,682; 4,861,376; 4,919,724; 5,252,754).

There are several drawbacks, however, with the foregoing internal and external sizing methods. Both create on the corrugating material a boundary layer of sizing agent before the linerboard is adhered to the corrugating material. As a result, a low end, inexpensive, water based adhesive can be ineffective in bonding the linerboard to the corrugating material in the making of the containerboard, since the water transfer mechanism of the adhesive is inhibited from passing through the boundary layer to effect an adhesion is inhibited from passing through the boundary layer to effect an adhesion of the liner-board to the underlying layer of corrugating material. Lower machine speeds or the use of a high end, non-aqueous based adhesive can be used to improve adhesion performance through such a barrier layer of sizing material. But lower machine speeds reduce process efficiency and high performance glues can increase process costs.

In addition, both internal and external sizing processes occur during the papermaking process. As a result, an inventory of sized corrugating material is always required at the site of the corrugating machine to meet customer demand. Any imbalances between available corrugating material and customer demand can, if the imbalance is deficient on the available material end, result in unfilled customer orders. If the deficiency occurs on the customer demand end, the result can be unused inventory. Either imbalance can result in increased costs.

Moreover, one of the more effective sizing agents being used in prior art methods today is wax-based. Containerboards manufactured in this way require disposal in a landfill after use. A sizing process that overcomes the foregoing problems in a more environmentally friendly way can lead to a containerboard product at a reduced cost with an enhanced product image.

SUMMARY OF THE INVENTION

An object of this invention is to provide a process for fabrication of a corrugated containerboard having high strength characteristics when exposed to high humidity or wet conditions.

Another object of this invention is to provide a corrugating material for use between a pair of spaced apart linerboards in a corrugated containerboard which is highly water resistant and will retain its strength properties under high humidity or wet conditions.

Another object of this invention is to provide the foregoing process under conditions that can minimize cost through the use of lower performance water based adhesives, faster machine speeds, and reduced inventory requirements at the corrugator facility.

While the above are the broad objects of this invention, a preferred embodiment of this invention provides the foregoing process by employing a sizing medium which is more environmentally friendly in that it allows containerboards so manufactured to be recycled. In particular, an alkyl ketene dimer or an alkyl ketene dimer combined with a starch or starch analog is employed to form the sizing barrier for such containerboards.

In accordance with this invention, there is provided a process for sizing corrugating material for use between a pair of spaced apart linerboards in a corrugated containerboard whereby corrugating material is wetted on one or both sides with a coating of a sizing agent, preferably any environmentally friendly sizing agent such as alkyl ketene dimer (AKD) or an alkyl ketene dimer combined with a starch or starch analog, and while in a wetted state, said corrugating material is: (1)

extended through a corrugating machine, (2) adhered on one or both sides to adjacent surfaces of adjacent sheets of liner paper using conventional adhesives, (3) passed through a heating station to so cure the adhesives so as to adhere the still AKD or AKD/starch wetted corrugating material to the adjacent sheets of liner paper, and (4) subsequently cured for a sufficient duration of time to fully cure the AKD or AKD/starch coating on said corrugating material.

The above objects and advantages will become clear to those skilled in the art when taken in connection with the detailed description of the invention and the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a flow diagram schematically illustrating the process for treating the corrugating material of the present invention;

FIG. 2 is a perspective view of a corrugating material as it emerges from corrugating station 50 in accordance with this invention;

FIG. 3 is a perspective view of a two ply configuration for a corrugated containerboard formed in accordance with this invention; and

FIG. 4 is a perspective view of a three ply configuration for a corrugated containerboard formed in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

In the practice of this invention a corrugated containerboard is formed on a modified corrugating machine 10. As shown in FIG. 1, corrugating machine 10 comprises a single face liner roll 20, a corrugating material roll 22, a double face liner roll 24, a sizing agent station 40, a corrugating station 50, a single face glue station 60, a double face glue station 64, a bridge 70, a heat station 80, and a cooling station 90.

Corrugating material 30 having a first and a second side (32, 34; shown in FIG. 2 after it has been corrugated by corrugating station 50 as described below) is deemed to be well

known to those skilled in the art. The corrugating material is porous in nature. Corrugating material 30 on corrugating material roll 22 is drawn through sizing station 40. There both sides of said corrugating material is coated with a sizing agent of choice. For decreased sizing performance, only first side 32 of said corrugating material may be coated with sizing agent at sizing station 40. Alternatively, either side 32, 34 of said corrugating material may be coated with sizing agent anywhere in the corrugation process so long as sizing agent is applied to said corrugating material before said corrugating material is contacted with an adhesive as described below.

Preferably, the sizing agent is an alkyl ketene dimer (AKD), or an AKD combined with a starch or a starch analog. This is an environmentally friendly sizing agent that permits a containerboard manufactured employing it to be recycled. Non-environmentally friendly materials require disposal in a landfill after use. In the preferred embodiment, the formulation of AKD used is that available from Hercules under product designation Hercon 70. Alternatively, any sizing agent that will provide the desired sizing to the corrugating material can be used.

The AKD sizing agent or AKD/starch formulation can be applied to the moving medium web by a variety of means:

1. A spray system comprised essentially of a header and nozzles which will direct a given quantity of the formula unto the web.
2. A system comprised essentially of a roller(s) that could be smooth, engraved, wire wound, grooved, or modified otherwise which will transfer the formula from the rollers (directly or indirectly) unto the medium.
3. A system whereby the medium is in intimate contact with a headbox type of device (a controllable slit at bottom of a vessel).
4. A system whereby the medium is immersed into the formula and subsequently metered by rollers (smooth, engraved, wire wound, grooved, or modified otherwise).

5. A system whereby the formula is applied to the medium and metered by a plate or blade (bent, trailing, etc.).

To achieve total resistance to moisture penetration, the AKD can be applied to the medium at a minimum of 10 pounds (dry basis) per ton of medium, preferably 15 lbs/ton distributed between the top and bottom surfaces of the medium. A treatment to a single surface will produce medium with acceptable performance attributes.

The sizing agent when complimented with a starch produces a formula which has the added benefit of increasing the compressive strength of the medium. The increase in this strength improves the container's performance. The quantity of starch used is dependent on the strength improvement desired and can range from 5 to >200 pounds starch per ton cellulose fiber.

Preferably, the sizing station is a Dahlgren coater. The Dahlgren coater makes use of rolls which transfer liquids from a pan onto rolls and subsequently to a substrate. One preferred type of Dahlgren coater is manufactured by BTG and sold under the trademark LAS®. An arrangement of spray nozzles can be used as well. The nozzles are connected either directly or indirectly with tubing to a HEADER apparatus mounted above the corrugating material. Any apparatus which delivers to the corrugating material the sizing agent of choice at the desired levels to produce the desired coating configuration and sizing performance properties can be used.

The spray system makes use of headers, nozzles and spray nozzle pressure which are regulated to deliver a uniform volume of sizing agent to a moving web. When an arrangement of manifolds are used, one can be placed on each side of the corrugating material. The manifolds are spaced approximately 24 inches apart from each other, and are positioned about 12 inches away from the corrugating material. Each manifold has a row of jet nozzles, spaced about 12 inches apart along the cross direction. The manifolds are designed to deliver sizing agent pressures to the nozzles in the range of 20-100 psi. The jets eject a divergent fan jet of sizing agent downwardly on the

corrugating material and can be angled to provide for desired continuous coating. The divergence of the fan jets allow overlap of sizing agent at the surface of the corrugating material to thereby form a more even strip of sizing agent across the width of the corrugating material.

Corrugating material 30 so coated with a sizing agent, such as AKD or AKD/starch, is drawn through corrugating station 50 which includes two corrugating dies 52 and 54. There the corrugating material is bunched into fluted pleats 32 as shown in FIG. 2 arranged to define tips 36, 37 at the ends thereof. Tips 36 are shown formed on said first side of said corrugating medium and tips 37 are shown formed on said second side thereof. The perspective view shown in FIG. 2 of corrugating material 30 as it emerges from corrugating station 50 illustrates the resulting folds of corrugating pattern imparted onto the corrugating material by the corrugating station. Fluted pleats 32 can be seen there to extend across the corrugating material in the cross direction.

A preferred corrugating station 50 is the type manufactured by UNITED Container Machinery Group, Inc. The operation of a corrugating station is to create flutes in the material by sandwiching the material between a pair of corrugating dies 52 and 54. Alternatively, any corrugating station that provides the corrugation of choice can be used.

Corrugating material 30 is next drawn through first glue station 60 shown in FIG. 1. The glue station 60 includes rollers 62 and 63 which facilitate movement of the adhesive onto the advancing material. Any suitable application process may be practiced. The adhesive is applied to tips 36 of fluted pleats 32 (shown in FIG. 2) of said corrugating material as it passes through said glue station. An adhesive, such as an aqueous suspension of starch, may be used. The starch may incorporate a variety of additives to enhance its performance. Formaldehyde may be an additive. Application rates vary so as to coincide with the rate the liner is bonded to the material.

As shown in FIG. 3, liner paper 91 drawn from liner roll 20 (see FIG. 1) is pressed against first side 32 of

corrugating material 30 emerging from glue station 60 so as to bring said liner paper into contact with said adhesive layer on tips 36 of said corrugating material 30. In this way said liner paper is adhered to said corrugating material to form a two part structure of linerboard-to-corrugating material 38 for use as containerboard.

Advantageously, maintenance of the sizing agent in wetted state throughout this gluing process allows adhesive from glue station 60 to migrate through the AKD or AKD/starch sizing barrier on said corrugating material and to permeate the underlying corrugating material to the degree necessary to accomplish an effective adhesion of liner paper 91 to said corrugating material. Curing of said glue as two ply containerboard 38 moves down the line of said corrugating machine and is passed through heat station 80 as later described, causes said glue to adhere said liner paper 91 through said sizing agent of said corrugating material to said corrugating material to form a two ply containerboard 38. The unique sizing agent remains in a wetted state thereby allowing the glue function in its maximum capacity.

As shown in FIG. 1, corrugating material 30 with liner paper 91 lightly adhered thereto is typically drawn onto a bridge 70. Build-up is usually effected by one or more apparatus along said bridge 70 which typically backfold incoming two play as required to control the further operations down the line. Here, the two ply containerboard 38 is allowed to que through build-up until the lead section of the two-ply is drawn through to the next step of the corrugation process.

When a three ply configuration is desired, the two ply containerboard 38 from bridge 70 is drawn through second glue station 64. The glue station 64 includes glue rolls, 67 and 68, to facilitate movement of the adhesive onto the moving two ply containerboard. An adhesive layer is applied to tips 37 of fluted pleats 32 of said corrugating material (see FIG. 3) as they pass through said glue station. Alternately, the system can have a dispensing bar which is aligned in the cross direction perpendicular to the machine direction of the corrugating

material. As previously described, any suitable glue or application process can be used. One preferred glue is starch based glue and can contain additives such as formaldehyde. The rate of application can be varied to accommodate various adhesives.

Liner paper 92 drawn from liner roll 24 is pressed against second side 34 of corrugating material 30 at glue station 64 so as to bring said liner paper into contact with said adhesive layer on tips 37 of said corrugating material. In this way, said liner paper is adhered to said corrugating material to form a three ply structure of linerboard-to-corrugating material-to-linerboard for use as a corrugated containerboard. Advantageously, the still wetted state of the sizing agent during the gluing process allows glue to migrate adequately across the sizing agent barrier and into said underlying corrugating material to accomplish effective adhesion of linerboard to corrugating material.

Three ply containerboard configuration 39 emerges from second glue station 64 and is passed under heat station 80. There the glue applied at glue stations 62, 64 completes the curing process. The sizing agent is only partially cured. The sizing agent does not undergo a transition when partially cured after the adhesive has been cured and applied to the corrugating material. The sizing agent directly reacts with the cellulose to form a covalent bond.

The time required for adhesive to cure can vary depending on the process parameters, including machine speed, thickness of adhesive coating applied during the corrugation process, and the like.

Uncorrugated corrugating material 30 is coated with a sizing agent at station 40 and the coated material is then bunched into fluted pleats arranged to define tips at the ends thereof. The adhesive is applied onto the sizing agent coating on the tips of the fluted pleats formed on one side of the corrugating material. A liner is attached to the adhesive layer on the tips to form a two-part structure of linerboard to corrugating material for use as a corrugated container board.

Curing of the sizing agent begins after contact with the heat station in the process.

Curing of said sizing agent occurs throughout the entire process in varying degrees, but is generally marginal until the corrugated containerboard is passed through heat station 80, where a significant amount of curing can occur, again depending on the type of sizing agent used, the thickness of the sizing coating applied, the speed of the machine, and the like. Additional curing of the sizing agent that is required occurs after the corrugated containerboard is brought off-line and stored pending use. Cure is a term of art wherein two molecules are linked by a covalent bond.

While the preferred sizing agent for use in this invention is AKD, any aqueous or non-aqueous based system may be employed depending on processing requirements and the sizing requirements required of the corrugated container. Other sizing agents, such as alkyl succinic anhydride (ASA), stearic acid anhydride, alkyl isocyanate, styrene maleic anhydride, may also be used provided they are so formulated as to retain wettability and maintain minimum cure during the time that the linerboard is adhering to the corrugating material during manufacture of the corrugated containerboard. Other sizing agents, such as a rosin-alum emulsion, a styrene acrylic, an alkyl substituted polyurethanes can be formulated in appropriate proportions with AKD, or other environmentally friendly agents, with appropriate curing properties, may also be used. The sizing agent may include a minor amount of the rosin-alum emulsion, styrene acrylic or alkyl substituted polyurethane additive.

Where AKD is the sizing agent of choice, the formulation of choice is an alkyl ketene dimer formulated by Hercules under product designation Hercon 70. It will be appreciated by those skilled in the art that an alkyl ketene dimer formulated with other additives and ingredients, such as fortified rosins, micro crystalline waxes, organic acid anhydrides, organic isocyanate or mixtures thereof can be used. The particular formulation depends upon the process requirements and the performance criteria demanded of the corrugated container.

The AKD or analog can be combined with a starch or starch analog to produce a desirable sizing agent medium. While starch is the preferred low cost strengthening agent, other alternatives include carboxymethylcelluloses and similar analogs, polyvinyl alcohols and acetates, derivatized starches, proteins, latexes and a variety of resins, gums and polymers with film-forming capabilities provided they do not impact or alter the process unduly. The starch or starch analog can be starch, carboxymethyl cellulose, polyvinyl alcohol, polyvinyl acetate, derivatized starch, modified starch, protein, starch latex copolymers, carrageenan gum, sodium alginate, polyethylene glycol or cross-linked acrylic polymers.

While the material noted here is AKD, it is reasonable to expect other chemicals capable of imparting water resistance would perform a similar function such as rosin-alum systems, alkyl substituted polyurethanes, alkenyl anhydrides, styrene maleic anhydrides (esters and salts), alkyl isocyanates, stearoyl chloride, polyacrylates, styrene acrylic acids, alkylated melamine, and modified polyethylene.

Another alternative is to add a wet strength agent such as polyamidoamine-epichlorohydrin, glyoxylated polyacrylamide, urea (or melamine) formaldehyde resin(s) to enhance the desired effect of altering the cellulose fiber's affinity/interaction with water.

While the coater used to apply AKD or AKD/starch has been described as a Dahlgren type coater, it will be appreciated that there are other ways in which the sizing agent at sizing station 40 can be applied. For example, a spray system comprising a header and nozzles can be used to direct an AKD or AKD/starch onto a web at a prescribed rate. A system of rollers can be used to transfer the AKD or AKD/starch from the rollers directly or indirectly onto the corrugating material. Such rollers can be smooth, engraved, wire wound, grooved or contain other configurations. Yet another system can employ a headbox type of vessel provided with a controllable slit along a bottom surface of the vessel. Such a vessel is preferably placed at a minimum distance from the corrugating material to optimize the

coating quality and control. As yet another alternative, the medium can be immersed in a vessel containing AKD or AKD/starch. The corrugating material can be drawn through the vessel and subsequently released with rollers. Such rollers can be smooth, engraved, wire wound, grooved and contain other configurations to produce the desired coating effect. As still another alternative the AKD or AKD/starch can be introduced onto the corrugating material along a predetermined region and such AKD or AKD/starch so introduced can be metered to the desired coating thickness using a plate or blade. Such metering devices can be bent, or take on other configurations to accomplish the desired metering results.

There are several process parameters that can be controlled to create an AKD or AKD/starch coating suitable for a designated end use application. The controlling factor determining any set of process parameters is the need to retain the wettability of the sizing agent beyond the point that adequate adhesion of the liner paper to the corrugating material has occurred. This is necessary to permit the glue of choice to migrate through the sizing barrier to the corrugating material in order to effect adequate adhesion of the liner paper to the corrugating material. Thus, for example, if a quick drying sizing agent is selected, a quicker machine speed for the corrugating machine will need to be selected that will ensure, under the prevailing temperature, humidity, and other atmospheric conditions present during the corrugation process, that the sizing agent maintains wettability throughout the gluing process. As another example, a slower machine speed may be appropriate when a slow drying agent is used.

The use of liquids during the corrugating process can create process difficulties such as adhesion and wrapping of the medium onto the corrugating rolls, weaving or folding of the medium on the rolls, inadequate bonding of the medium to the liners in one form or another, uptake of moisture by the liners to create warped product, etc.

However, the controlled application of a sizing agent does produce a medium capable of resisting moisture intrusion via

surfaces or edges. This can be accomplished with minimal (if any) interference to the corrugating process while improving product performance. However, the sizing agent, in itself, does not contribute significantly to the medium's compression strength, as compared to wax. Starches are known to enhance compression properties at a low cost. The addition of starch to the sizing agent yields a preferred low cost formula embodiment.

Examples 1-14 set forth some process parameters for practicing the invention according to the preferred embodiment. Examples 1-7 show data for a containerboard taken after the containerboard emerges from the corrugating machine while Examples 8-14 show data from runs analogous to those depicted in Examples 1-7 but taken after the containerboard emerging from the corrugating machine has been cured for 16 hours at 140°F.

WICKING TEST:

Cut sample 6" cd x 1" md

Hang sample so 1" is immersed in 20°C water for 24 hours

Edge wicking is measured by the height (in) water has risen in the sample above the initial 1"

Unsized medium will have 5" (i.e.: 1" initial and 5" wick = 6" sample)

COBB TEST:

This is a procedure for determining the quantity of water absorbed by paper in a specified time under specified conditions. Test parameters and conditions are outlined in the publication, Water absorptiveness of sized (non-bibulous) paper and paperboard. (Cobb Test), TAPPI, T441 om-90.

Examples 1-7 relate to uncured material, while Examples 8-14 relate to cured material.

Example 1

A 30 lb./per 1000 sq. ft. non-waxed corrugated material was processed through a conventional corrugating machine. Two minute Cobb tests performed on the corrugated containerboard on the wire side of the containerboard show results of 312 grams/sq. meter and on the felt side of the containerboard results of 307 grams/sq. meter. CD wicking tests gave wire side and felt side results of more than 3 inches each.

Example 2

A 30 lb. non-waxed corrugated material was processed through a corrugating machine of Example 1 modified in accordance with this invention. Hercon 70 AKD was applied using a Dahlgren LAS unit to one side only of the 30 lb. HC non-waxed paper at the rate of 2.5 lbs./MSF. Two minute Cobb tests performed on this containerboard showed wire results of 211 grams/sq. meter and felt results of 214 gram/sq. meter. CD wicking tests showed wire results of 0 inches and felt results of 3 inches.

Example 3

A 30 lb. non-waxed corrugated material was processed through a corrugating machine of Example 1 modified in accordance with this invention. Hercon 70 AKD was applied using a Dahlgren LAS unit to one side only of the 30 lb. HC non-waxed paper at the rate of 2.8 lbs./MSF. Two minute Cobb tests performed on this containerboard showed wire results of 190 grams/sq. meter and felt results of 199 grams/sq. meter. CD wicking tests showed wire results of 0 inches and felt results of 3 inches.

Example 4

A 30 lb. non-waxed corrugated material was processed through a corrugating machine of Example 1 modified in accordance with this invention. Hercon 70 AKD was applied using a Dahlgren LAS unit to one side only of the 30 lb. HC non-waxed paper at the rate of 3.0 lbs./MSF. Two minute Cobb tests performed on this containerboard showed wire results of 189 grams/sq. meter and felt results of 188 grams/sq. meter. CD wicking tests showed wire results of 0 inches and felt results of 3 inches.

Example 5

A 30 lb. non-waxed corrugated material was processed through a corrugating machine of Example 1 modified in accordance with this invention. Hercon 70 AKD was applied using a Dahlgren LAS unit to one side only of the 30 lb. HC non-waxed paper at the rate of 5.5 lbs./MSF. Two minute Cobb tests performed on this containerboard showed wire results of 65 grams/sq. meter and felt results of 131 grams/sq. meter. CD wicking tests showed wire results of 0 inches and felt results of 2.1 inches.

Example 6

A 30 lb. non-waxed corrugated material was processed through a corrugating machine of Example 1 modified in accordance with this invention. Hercon 70 AKD was applied using a Dahlgren LAS unit to one side only of the 30 lb. HC non-waxed paper at the rate of 8.5 lbs./MSF. Two minute Cobb tests performed on this containerboard showed wire results of 48 grams/sq. meter and felt

results of 128 grams/sq. meter. CD wicking tests showed wire results of 0 inches and felt results of 1.7 inches.

Example 7

A 30 lb. waxed corrugated material was processed through a corrugating machine of Example 1. Two minute Cobb tests performed on this containerboard showed wire results of 34 grams/sq. meter and felt results of 27 grams/sq. meter. CD wicking tests showed wire results of 0.1 inches and felt results of 0.1 inches.

Example 8

A 30 lb. non-waxed corrugated material was processed through a corrugating machine. Containerboard so produced was cured 16 hours at 140°F. Two minute Cobb tests performed on the corrugated container showed wire results of 276 grams/sq. meter and felt results of 273 grams/sq. meter. CD wicking tests gave wire results and felt results of more than 3 inches each.

Example 9

A 30 lb. non-waxed corrugated material was processed through a corrugating machine of Example 1 modified in accordance with this invention. AKD was applied using a Dahlgren LAS unit to one side only of the 30 lb. HC non-waxed paper at the rate of 2.5 lbs./MSF. Containerboard so produced was cured 16 hours at 140°F. Two minute Cobb tests performed on this containerboard showed wire results of 23 grams/sq. meter and felt results of 38 gram/sq. meter. CD wicking tests showed wire results of 0 inches and felt results of .1 inches.

Example 10

A 30 lb. non-waxed corrugated material was processed through a corrugating machine of Example 1 modified in accordance with this invention. AKD was applied using a Dahlgren LAS unit to one side only of the 30 lb. HC non-waxed paper at the rate of 2.8 lbs./MSF. Containerboard so produced was cured 16 hours at 140°F. Two minute Cobb tests performed on this containerboard

showed wire results of 24 grams/sq. meter and felt results of 38 grams/sq. meter. CD wicking tests showed wire results of 0 inches and felt results of .1 inches.

Example 11

A 30 lb. non-waxed corrugated material was processed through a corrugating machine of Example 1 modified in accordance with this invention. AKD was applied using a Dahlgren LAS unit to one side only of the 30 lb. HC non-waxed paper at the rate of 3.0 lbs./MSF. Containerboard so produced was cured 16 hours at 140°F. Two minute Cobb tests performed on this containerboard showed wire results of 22 grams/sq. meter and felt results of 35 grams/sq. meter. CD wicking tests showed wire results of 0 inches and felt results of .1 inches.

Example 12

A 30 lb. non-waxed corrugated material was processed through a corrugating machine of Example 1 modified in accordance with this invention. AKD was applied using a Dahlgren LAS unit to one side only of the 30 lb. HC non-waxed paper at the rate of 5.5 lbs./MSF. Containerboard so produced was cured 16 hours at 140°F. Two minute Cobb tests performed on this containerboard showed wire results of 33 grams/sq. meter and felt results of 30 grams/sq. meter. CD wicking tests showed wire results of 0 inches and felt results of .1 inches.

Example 13

A 30 lb. non-waxed corrugated material was processed through a corrugating machine of Example 1 modified in accordance with this invention. AKD was applied using a Dahlgren LAS unit to one side only of the 30 lb. HC non-waxed paper at the rate of 8.5 lbs./MSF. Containerboard so produced was cured 16 hours at 140°F. Two minute Cobb tests performed on this containerboard showed wire results of 25 grams/sq. meter and felt results of 31 grams/sq. meter. CD wicking tests showed wire results of 0 inches and felt results of .1 inches.

Example 14

A 30 lb. waxed corrugated material was processed through a corrugating machine of Example 1. Containerboard so produced was cured 16 hours at 140°F. Two minute Cobb tests performed on this containerboard showed wire results of 34 grams/sq. meter and felt results of 27 grams/sq. meter. CD wicking tests showed wire results of 0 inches and felt results of 0 inches.

From the above Examples, it will be seen that treated corrugating material converted in accordance with this invention show wettability performance characteristics, measured directly off the corrugating machine, Examples 2-6, that are better than wettability performance characteristics taken of a non-sized containerboard, Example 1. When the applied sizing agent in the containerboard is allowed to cure for 16 hours at 140°F, as in Examples 8-14, the wettability performance characteristics of the containerboard made in accordance with this invention, Examples 9-13, is seen to improve dramatically over the unsized containerboard, shown in Example 8, approaching the wettability performance characteristics of a sized containerboard of the type manufactured using prior art techniques, illustrated in Example 14.

While this invention has been described with reference to certain preferred embodiments, it will be appreciated that other apparatus and processes may be devised, which are within the scope and spirit of this invention.

WE CLAIM:

1. A method for sizing in a corrugating machine a corrugating material used in a corrugated containerboard, comprising the steps of:

coating a first side of an uncorrugated corrugating material with a sizing agent selected from the group consisting of an alkyl ketene dimer, alkyl succinic anhydride, alkyl isocyanate and styrene maleic anhydride in said corrugating machine;

corrugating said uncorrugated corrugating material into fluted pleats arranged to define tips at the ends thereof;

applying a starch adhesive layer to said coating of sizing agent on said tips of said fluted pleats formed on said first side of said corrugating material;

contacting a first linerboard to said adhesive layer on said tips formed on said first side of said corrugating material to form bond therebetween and a two part structure of linerboard-to-corrugating material for use as a corrugated containerboard;

completely curing said adhesive sufficiently by contact with a heat station to effect an adhesion of said linerboard to said corrugating material through said coating of sizing agent; and

partially curing said sizing agent by contact with said heat station.

2. The method of claim 1 comprising the further steps prior to completely curing of said adhesive:

applying a second starch adhesive layer to said coating of sizing agent on said tips of said fluted pleats formed on said second side of said corrugating material;

contacting a second linerboard to said second adhesive layer on said linerboard to said adhesive layer on said tips formed on said second side of said corrugating material to form a three part structure of linerboard-to-corrugating material-to-linerboard for use as a corrugated containerboard.

3. The method of claim 1 comprising the further step prior to curing of said adhesive and curing of said coating of sizing agent:

coating a second side of said corrugating material with a sizing agent selected from the group consisting of an alkyl ketene dimer, alkyl succinic anhydride, alkyl isocyanate and styrene maleic anhydride in said corrugating machine.

4. The method of claim 3 comprising the further steps prior to curing of said adhesive and curing of said coating of sizing agent of:

applying an adhesive layer to said coating of sizing agent on said tips of said fluted pleats formed on said second side of said corrugating material;

contacting a second linerboard to said adhesive layer on said tips formed on said second side of said corrugating material to form a three part structure of linerboard-to-corrugating material-to-linerboard for use as a corrugated containerboard.

5. The method of claim 3 wherein said sizing agent includes a minor amount of an additive of a rosin-alum emulsion, styrene acrylic or alkyl substituted polyurethane.

6. The method of claim 4 wherein said sizing agent includes a minor amount of an additive of a rosin-alum emulsion, styrene acrylic or alkyl substituted polyurethane.

7. A method for sizing in a corrugating machine a corrugating material used in a corrugated containerboard as claimed in claim 1, wherein said sizing agent further comprises a starch or starch analog.

8. A method for sizing in a corrugating machine a corrugating material used in a corrugated containerboard as claimed in claim 7, wherein said starch or starch analog is starch, carboxymethyl cellulose, polyvinyl alcohol, polyvinyl

acetate, derivatized starch, modified starch, protein, starch latex copolymers, carrageenan gum, sodium alginate, polyethylene glycol or cross-linked acrylic polymers.

9. A corrugator apparatus for sizing a corrugating material in said corrugator apparatus for use in a corrugated containerboard comprising:

a) a means for sizing a corrugating material having a first and second side in said corrugator apparatus;

b) means for corrugating said sized corrugating material to form a corrugated material in said corrugator apparatus;

c) means for applying an adhesive to said first side of said sized corrugating material;

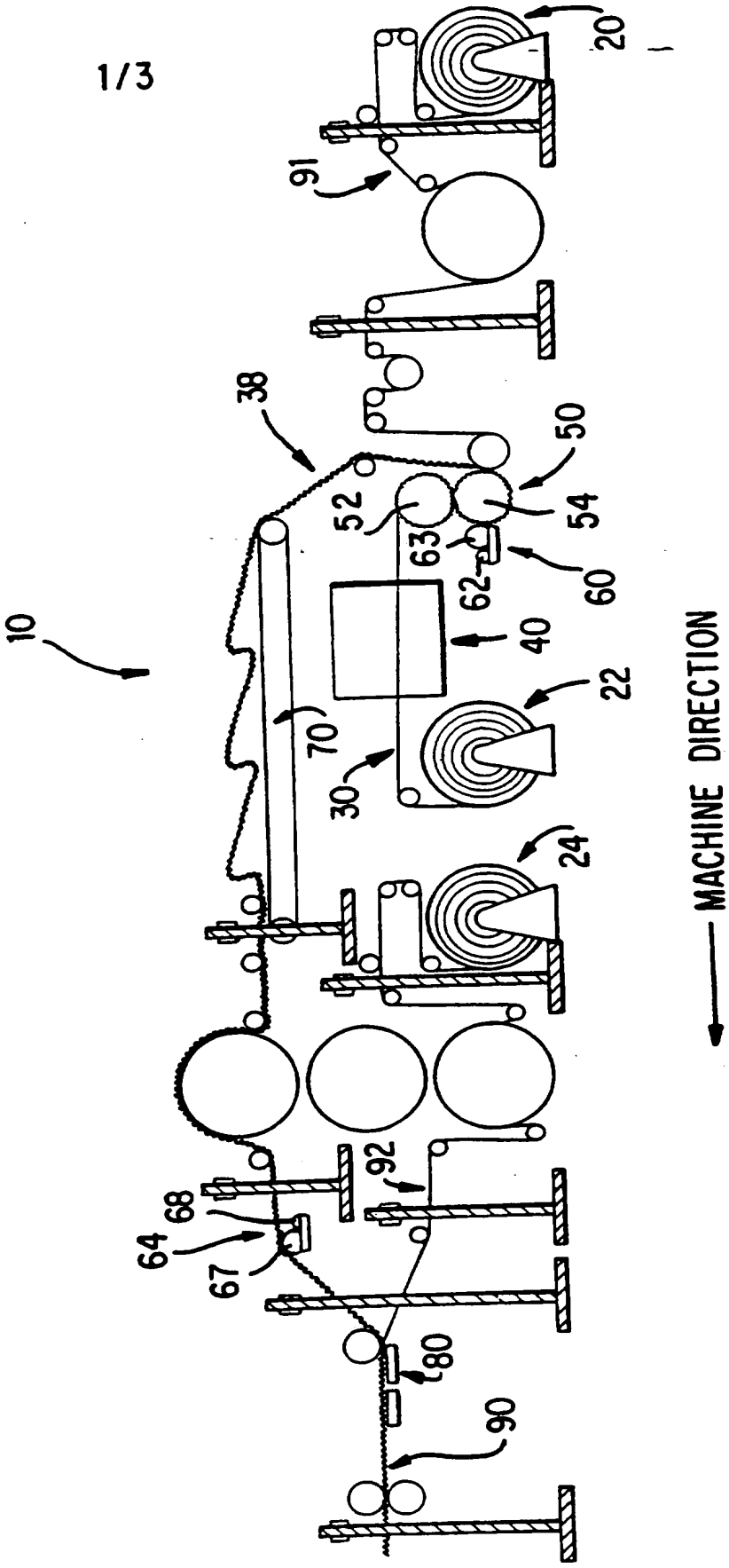
d) means for attaching a first linerboard to said first side of said sized corrugating material; and

e) means for curing said sizing to form a corrugated containerboard.

10. An apparatus as claimed in claim 9 further comprising:

f) means for applying a second adhesive to said second side of said sized corrugating material; and

g) means for attaching a second linerboard to said second side of said corrugated material.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MACHINE DIRECTION

FIG.1

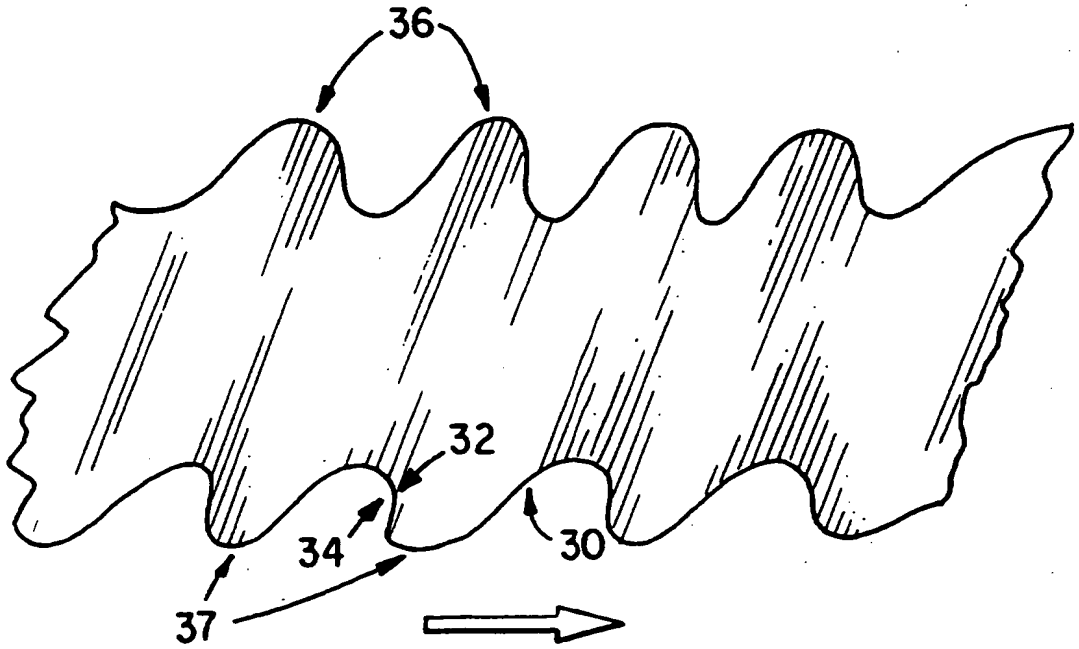

FIG. 2

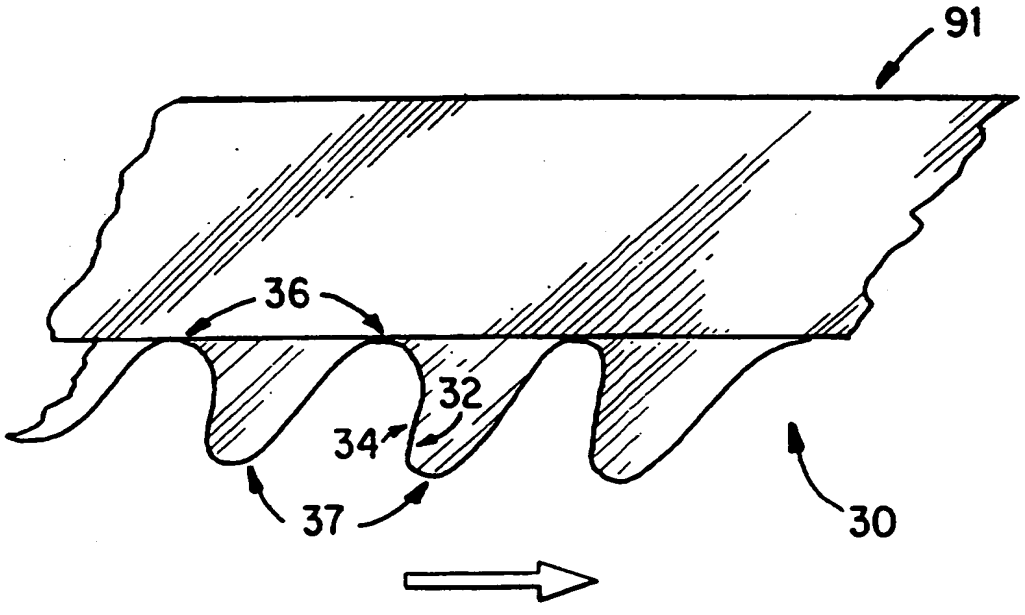

FIG. 3

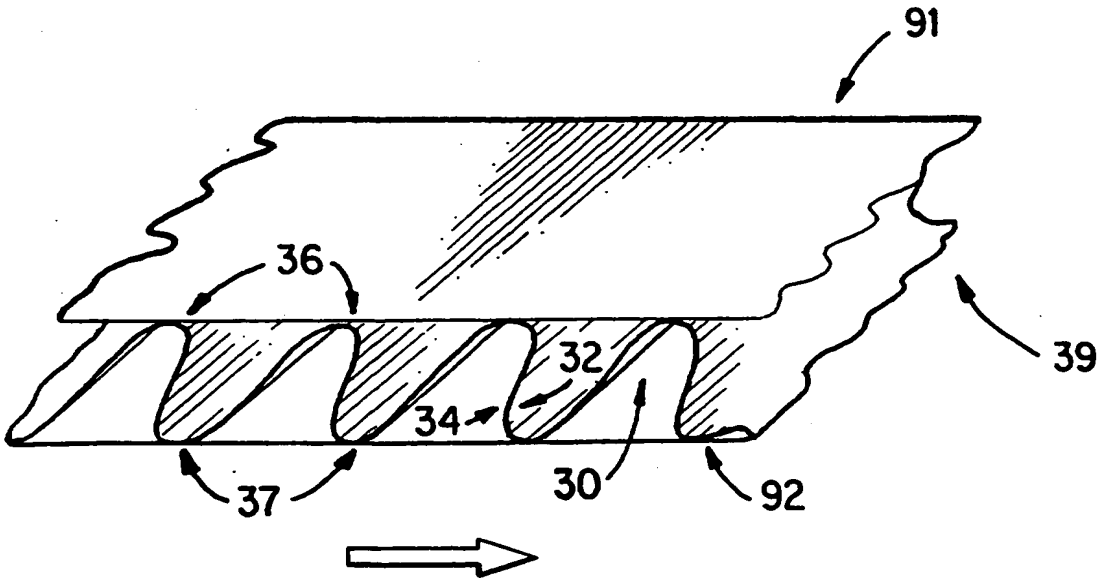

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/16814

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B31F 1/28
US CL : 156/205, 210, 471, 472
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 156/205, 210, 470, 471, 472

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

none

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

none

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 3,697,365 A (REISMAN et al) 10 October 1972, col. 5, line 59-col. 6, line 45.	9-10 ------ 1-8
X --- Y	US 4,096,305 A (WILKINSON et al) 20 June 1978, col. 3, lines 30-63 and figure 1.	9-10 ------ 1-8
Y	US 4,207,142 A (SHEPHERD) 10 June 1980, col. 6, lines 67-68.	1-8
Y	US 4,240,935 A (DUMAS) 23 December 1980, col. 1, lines 19-20.	1-8

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 11 DECEMBER 1996	Date of mailing of the international search report 28 JAN 1997
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Form PCT/ISA/210 (second sheet)(July 1992)*